I. Wallops Flight Facility (WFF)

WFF continues in its longtime role as NASA's principal facility for the management and implementation of suborbital science research programs. In addition, WFF has become a premier site for the operation of medium-class space launch vehicles. The research and responsibilities of Wallops are centered on the philosophy of providing a fast, low-cost, highly flexible, and safe response to meet the need of aerospace technology interests and science research.

The WFF Safety Office supports ground safety and flight safety analyses to ensure NASA safety rules and criteria are met. The WFF Safety Office also supports ground operations in preparation for flight and provides on-console support for flight operations as necessary. When other national ranges are involved with WFF missions, the WFF Safety Office provides documentation and operational support as required by the other range.

Listed below are various project/programs that the WFF Range Safety Organization supported in 2013.

1. Range and Mission Management Office

NASA/WFF Range Safety personnel supported multiple missions conducted by the WFF Range and Mission Management Office (RMMO) in 2013. The manifest included 5 Expendable Launch Vehicle (ELV) missions, 1 Department of Defense (DoD) Tracking Exercise, F-35 and X-47B flight testing, and 1 reimbursable mission for runway water ingestion (mandatory testing for FAA aircraft certification). The RMMO supports sounding rocket launches at WFF with fixed instrumentation as well as mobile range instrumentation for sounding rocket launches at other sites. The following provide some details of the ELV launches from WFF.

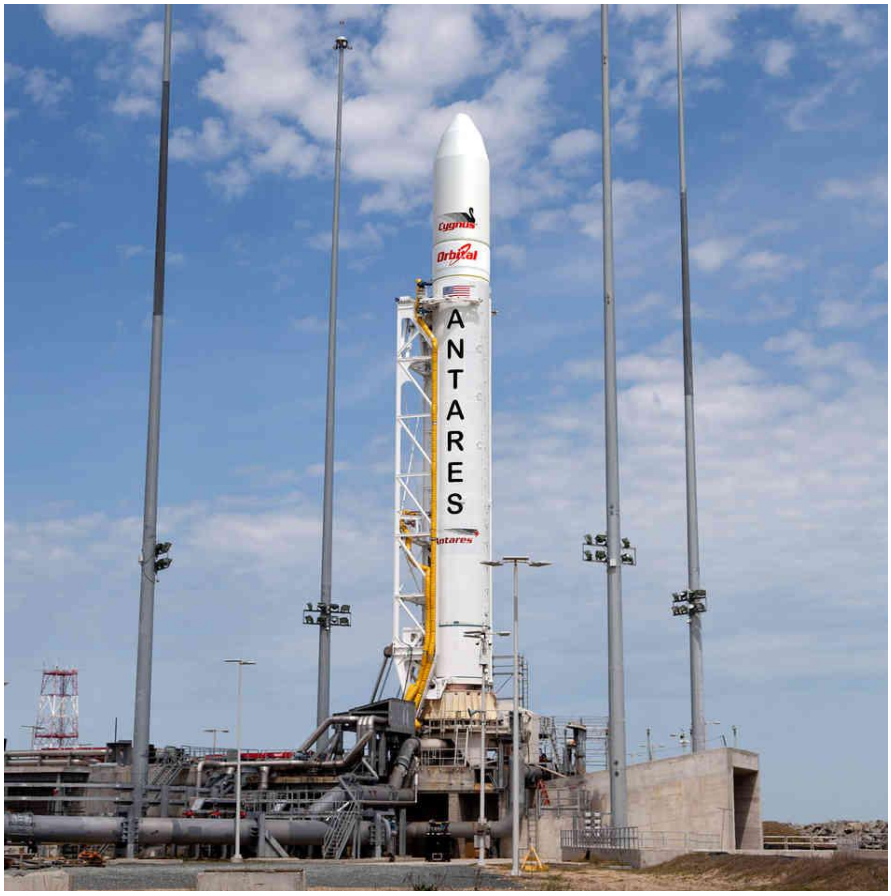

FIGURE 42: ANTARES ON THE PAD

a. ANTARES

After one of the largest launch infrastructure buildups and vehicle

development efforts in the history of the Wallops Research Range, 2013 marked the beginning of Antares launch operations. Antares (Figure 43) is a medium-class space launch vehicle built by Orbital Sciences Corporation (OSC) and is named after a red supergiant star in the Milky Way Galaxy. This brand-new launch vehicle was developed as part of the Commercial Orbital Transportation Services (COTS) contract for resupplying the ISS. The WFF Range supported two Antares launches in 2013.

The first-ever successful launch of the Antares vehicle on April 21, 2013 (A-ONE mission) was the culmination of an enormous multi-year effort. Antares perfectly placed a payload simulator into a short orbit and demonstrated its ability to carry the Cygnus spacecraft that will resupply the ISS. Range services provided for the Antares A-ONE mission included precision tracking radar, telemetry operations, range timing and communications, radio frequency monitoring, surveillance radar operations, range air and sea surveillance, NASCOM, weather forecasting, meteorological operations, optical systems, range scheduling services, range safety, and postproduction deliverables for prelaunch and launch operations.

One unique aspect of this mission was the teaming effort between WFF Optical Systems Group and a team from Kennedy Space Center. Together, these two teams produced the largest amount of photographic and video data ever collected by one mission. One key to successful range support for the A-ONE mission was the establishment and maintenance of downrange mobile tracking stations in Coquina, N.C. and Bermuda. These stations incorporate mobile power, telemetry, radar, and command.

FIGURE 43: ANTARES IN HORIZONTAL INTEGRATION FACILITY (HIF)

The second Antares launch of 2013, known as ORB-D1 (Figure 44), took place on September 18, 2013. This was the first Antares vehicle to actually carry the new Cygnus spacecraft which ferried approximately 1,800 pounds of supplies to the ISS. Following the successful launch of the Lunar Atmosphere and Dust Environment Explorer (LADEE), WFF had only 11 days to turn over and prepare the range for ORB-D1. This short turnover-time required intense project

management to facilitate the complex and interwoven schedules of two separate medium-class launch vehicles.

A bright future is forecast for Antares as two to three launches are scheduled for 2014.

Editor's Note: At the time of publication, the next Antares mission, ORB-1, launched on 9 Jan 2014.

FIGURE 44: ANTARES LAUNCH

b. LADEE

Aboard a Minotaur V expendable launch vehicle, LADEE lifted off from Pad 0B at WFF on September 6, 2013. After a near-flawless count and with perfect weather conditions, LADEE soared into a clear, beautiful sky on the first minute of the launch window. This spectacular night launch was visible up and down the east coast (Figure 45).

LADEE was sent to the moon to gather information about the fragile lunar atmosphere before further exploration disturbs it. This ground-breaking feat was the culmination of years of effort from multiple agencies

FIGURE 45: VIEW OF MINOTAUR V LADEE LAUNCH FROM NEW YORK CITY

across the country. LADEE was the first-ever interplanetary mission from WFF on the first Minotaur V launch vehicle ever flown (Figure 46). The LADEE project also spurred some major upgrades to Wallops Range facilities. The two biggest upgrades were the development of a new Launch Control Center and a new clean room facility.

The LADEE launch trajectory created particular challenges for WFF Range Safety as the near due east path brought hazard areas close to Chincoteague Island and other populated areas to the north of Wallops Island. The Range worked closely with local authorities to clear the needed areas and to establish safe viewing sites for the tens of thousands of spectators who came to witness this historic launch.

FIGURE 46: MINOTAUR V LAUNCH

The LADEE mission was a great success for the entire Wallops Range team and might pave the way for future interplanetary missions from WFF.

2. Sounding Rocket Program Office

NASA/WFF Range Safety personnel supported 23 missions conducted by the WFF Sounding Rockets Program (SRPO) in 2013. The launch manifest consisted of 2 technology development/demonstration missions, 2 undergraduate student outreach missions (Rock-Sat X and Rock-On), 17 science missions, and 2 reimbursable missions for the Department of Defense. Launch sites included Wallops Island (6 launches), Poker Flat Research Range (1 launch), Reagan Test Site (4 launches), and WSMR (12 launches). The following provide some details of the launches from WFF.

a. Lithium Canister Test

WFF launched a two-stage Terrier Mk70 Improved Orion sounding rocket January 29, 2013. This mission was flown to test the lithium deployment system, in particular the Lithium Canister Design to be used for future missions – Daytime Dynamo and Equatorial Vortex Experiment (EVEX). The experimental payload included two canisters, each using a different lithium loading technique. This successful mission was an exercise in timing as the launch needed to occur in twilight conditions because lithium requires solar illumination to be visible. At the same time, conditions on the ground needed to be sufficiently dark so that the lithium releases could be seen against the sky background.

b. Cosmic Infrared Background Experiment (CIBER)

The Cosmic Infrared Background Experiment (CIBER) successfully flew aboard a Black Brant XII sounding rocket June 5, 2013, from WFF's Pad 1 50K launcher. The purpose of this mission was to investigate the spectral and spatial properties of the extragalactic near-infrared background, and the mission required acquisition of multiple targets. This was the fourth flight that WFF supported under the CIBER banner but the first at the Wallops Range. Previous flights for CIBER were conducted at White Sands Missile Range, New Mexico in 2009, 2010, and 2012. After each flight, the experiment payload was recovered for post-flight calibrations and reflight. The principal investigator decided the payload would not be recovered for this fourth and final mission in order to use a more powerful sounding rocket to fly over the Atlantic

at a higher elevation. The experiment payload safely splashed down in the Atlantic Ocean more than 400 miles off the Virginia coast.

c. RockOn

In the early morning hours of June 20, 2013, a Terrier Mk12 Improved Orion sounding rocket took flight from the WFF's Pad 1 50K launcher. Approximately 30 students and faculty worked on multiple payloads for this mission. Several science experiments were onboard the vehicle including an experiment to determine if the intensity of ultraviolet radiation changes with altitude and an experiment to develop an ozone density profile in the atmosphere.

The RockOn workshop is intended to provide exposure to university undergraduate students and their instructors to space-based science missions. The long-term goal of the RockOn workshop is to provide a minimally subsidized, self-sustaining, annual training program for the university community. This year, the following universities participated:

- Carthage College
- Eastern Shore Community College
- Embry Riddle Aeronautical University
- Miami University
- Mitchell Community College
- The Naval Academy
- Temple University
- University of Nebraska

The RockOn workshop is a collaborative effort by the Colorado Space Grant Consortium (CSGC), the Virginia Space Grant Consortium (VSGC), and the Wallops Flight Facility.

d. Daytime Dynamo

A joint science project between NASA and the Japan Aerospace Exploration Agency (JAXA) was conducted to study a global electrical current called the “Dynamo” which sweeps through the ionosphere. WFF facilitated this study by launching two sounding rockets a mere 15 seconds apart. As luck would have it, WFF celebrated the nation’s 237th birthday with its own aerial show as the two vehicles took flight in the morning hours on Independence Day, 2013. The first vehicle, a Black Brant V, carried a payload that collected data on the neutral and charged particles in the ionosphere. The second rocket, a Terrier Mk70 Improved Orion, released a long trail of lithium gas to track how the upper atmospheric wind varies with altitude. These winds are believed to be the drivers of the Dynamo currents.

3. Balloon Program Office

NASA/WFF Range Safety personnel supported 11 missions conducted by the Balloon Program Office (BPO) during 2013. Flight operations were conducted from Fort Sumner, New Mexico; McMurdo, Antarctica; and Kiruna, Sweden in support of Space Science payloads as well as testing for a new launch technique. The Super Trans-Iron Galactic Element Recorder (SuperTIGER) experiment, launched on December 8, 2012, is measuring the abundance of rare elements heavier than iron among the flux of cosmic rays from our galaxy. SuperTIGER set a new duration record for the Balloon Program at over 55 days aloft (Figure 47).

FIGURE 47: SUPERTIGER LAUNCH

The BPO in collaboration with the Jet Propulsion Laboratory (JPL) also conducted tests of a new launch method in preparation for the Low Density Supersonic Decelerator (LDSD) mission in 2014. The launch method utilizes a static launch technique employing a static launch tower. The LDSD Launch Tower (Figure 48) was successfully tested during the Fort Sumner, New Mexico campaign. The next step will be to integrate a Star 48 rocket motor and the LDSD deployable aeroshell aboard the balloon for launch from the Pacific Missile Range Facility (PMRF) in Hawaii. Further plans include up to three additional flights in 2015 from PMRF.

FIGURE 48: LDSD LAUNCH TOWER

4. WFF Aircraft Office

The WFF Aircraft Office supported multiple airborne science missions during 2013 involving manned aircraft. The Wallops Safety Office supports these missions through review of hazardous systems being flown on those aircraft and participation in the airworthiness review process.

The Aircraft Office also supported UAS work, including the Hurricane and Severe Storm Sentinel (HS3) mission and acts as a divert field for UAS missions from the Naval Aircraft Warfare Center, Patuxent River, MD.

The Purpose of the HS3 mission is to obtain critical measurements in the hurricane environment in order to identify key factors and their role in storm intensity change. Two NASA Dryden Global Hawk (GH) UAS aircraft (Figure 49) were especially equipped with sensors to gather science data about hurricanes in the Atlantic Basin. One aircraft (GH N872NA, also called 872 and AV-6) has three sensors selected to fly around the perimeter of hurricanes and is known as the "Environmental GH." The other aircraft (GH N871NA, also called 871 and AV-1) has three sensors selected to fly through the top of hurricanes and is known as the "Over-Storm GH." Each aircraft typically flies flight durations of up to 26 hours and can fly up to 28 hours under ideal conditions. These two GHs have flown more than 500 flight hours since being acquired by NASA Dryden and are considered operational UAS aircraft.

2013 marked the second year in the five-year HS3 project, with about ten Global Hawk science flights per year. The Global Hawk aircraft operating from the Wallops Airport fly to the Gulf of Mexico, Caribbean, the western Atlantic, and the central and eastern Atlantic.

FIGURE 49: NASA GLOBAL HAWK ON APPROACH

The Aircraft Office also supports all range missions requiring active range surveillance with helicopter and fixed wing assets. The Wallops Safety Office provides the analysis and requirements for the ship surveillance areas.

5. WFF Mobile Range - Kwajalein Launch Campaign

WFF continued to enable worldwide research with its mobile range that consists of radar, telemetry, command and control and communications systems. These systems can be shipped to any launch location in the world.

This past year, the WFF mobile range was dispatched to the South Pacific to collect data on the Earth's ionosphere to study radio frequency propagation as well as space weather and its impact on communication and navigation systems. WFF Range Safety developed the ground and flight safety plans for this campaign and provided on-site operational safety support. Between May 1 and May 9, 2013, two pairs of sounding rockets were launched. Each pair was launched nearly simultaneously during the successful Kwajalein launch campaign. These suborbital vehicles flew from Roi-Namur Atoll, Republic of the Marshall Islands (Figure 50). Two rockets supported the Equatorial Vortex Experiment, or EVEX – a NASA mission – and two supported the Metal Oxide Space Cloud experiment, or MOSC, which was a DoD mission.

FIGURE 50: SECOND SOUNDING ROCKET LAUNCH FROM ROI-NAMUR ATOLL, REPUBLIC OF THE MARSHALL ISLANDS

The EVEX mission studied space weather in the ionosphere, specifically the circulation of ionized gas, the intensity of which is believed related to post-sunset ionospheric storms that can impact satellite communication and navigation systems and signals. As part of the mission and during rocket flights, red and white vapor clouds formed to allow the scientists to observe the winds in the upper atmosphere. The MOSC payloads released a Samarium vapor creating a red cloud of charged particles in the ionosphere (Figure 51). Researchers from the Air Force Research Laboratory studied the cloud as it dispersed and its impact on radio transmissions sent from multiple locations. MOSC was launched with the assistance of the Department of Defense Space Test Program.

FIGURE 51: SAMARIUM VAPOR CLOUD IN THE IONOSPHERE